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the concrete course of mortar covering the earth in which the body reposed, which was broken up by the violaters of the tomb.

A notice of the occurrence of a Metallic Alloy in an unusual state of aggregation and molecular arrangement, was read by Robert Mallet, Esq., M. R. I. A.

Amongst the several classes of substances which chemistry at present considers as simple, the metals stand preeminently marked by their almost invariable possession of a nearly fixed and striking group of sensible qualities, which together constitute the well known "metallic character." Some of these, such as lustre and fusibility, are common to every metallic body; but by the occasional variation of nearly every other sensible quality of the metals, the law of continuity remains unbroken, which unites them in different directions with the other classes of material bodies. Thus opacity, which is probably mechanically destroyed in gold leaf, is lost in selenium; and so, in this most prevalent of their properties, the metals, through tellurium, selenium and sulphur, become translucent, and mingle with the nonmetallic elements. So also their solidity, at common temperature, is lost in mercury; their great density, in sodium and potassium; their malleability, in bismuth, antimony, and arsenic; while in tellurium, the power to conduct electricity is nearly wanting; and, lastly, hydrogen, to all intents a metal in its chemical relations, yet possesses not a single physical quality in common with these, but exists as an invisible and scarcely ponderable gas.

But although *different* metals thus vary in sensible qualities, those which collectively belong to *the same* individual metal are as remarkable for their permanence.

Unless selenium be admitted to be a metal, no approach to dimorphism has hitherto been recognized in any body of the class; the only case recorded, that by Dufresnoy, of the occurrence of cast iron in cubes and rhomboids, not having

been given by him with certainty, nor since verified by other observers. Hence any instance of such a character, or tendency towards it, is worthy of attentive consideration ; and it was with this view that the author brought before the Academy the following notice of the occurrence of an alloy of copper, in two states, having totally different sensible and physical qualities, while identical in chemical constitution. The alloy in question, in its original or normal condition, was in fact a species of brass ; and the particular specimen presented to the Academy was a portion of one of the brass bearings, or beds, in which the principal shaft of a large steam engine revolved.

The bearing, or bed of a shaft (as is generally known), consists of a hollow cylinder, generally of brass, divided in two by a plane passing through the axis ; its inner surface is finely polished, and sustains the shaft, during its revolution, which is also polished ; the cavity of the brass being completely filled by the shaft, which, in the present instance, was of cast iron, and about nine inches in diameter.

It frequently happens, notwithstanding the polish of both metallic surfaces, and the application of oil, that the friction due to their rapid passage over each other, while exposed to undue or irregular pressure, produces a considerable rise of temperature, and the brass becomes abraded. Its particles have no coherence, and much resemble the “ bronze powder” used by painters.

In an instance, however, which some time since came under the author’s notice, a different result took place. The minute particles of abraded brass were by the motion of the shaft, during a few hours, impacted into a cavity, at the junction of the two semicylinders of the bearing, where they became again a coherent mass, and when removed presented all the external appearance of an ingot or piece of brass, which had been poured in a state of fusion into the cavity. On more minute examination, however, the mass was found to

differ much in properties from the original brass, out of which it was formed.

The mass or ingot of brass, thus formed by the union of particles at a temperature which had never reached that of boiling water, and a fragment of which was presented, possessed on that side which had been in contact with the shaft, a bright polished metallic surface, like that of the original metal from which it had been formed: its other surfaces bore the impress of the cavity in which it was found. It was hard, coherent, and could be filed or polished like ordinary brass. It was, however, perfectly *brittle*; and when broken, the fracture, in place of possessing a sub-crystalline structure, and metallic lustre, like that of the normal brass or alloy, was nearly *black*, and of a fine grained *earthy* character, and *without any* trace of *metallic lustre* or appearance.

Examined with a lens, some very minute pores or cavities are found throughout its substance, which is uniformly of a very dark brown or nearly black colour, and devoid of all metallic character, except when cut or filed—that is, in mineralogical language, its colour is earthy black, and its streak metallic.

The author remarked that the observed cases of aggregation in solid particles, without the intervention either of a solvent or of fusion, are extremely rare, and as bearing upon the little understood subject of cohesive attraction, are of much interest.

The property of welding; which is possessed by all bodies, whether metallic or not, which pass through an intermediate stage of softness or pastyness previous to fusion, and is not found in any substance which readily crystallizes, and hence passes “*per saltum*” from the solid to the liquid state by heat, forms a “*frontier instance*” of cohesive forces, being enabled to act in the aggregation of bodies, by only an approach to liquidity, or by a very small degree of intermobility.

Aggregation may also take place between portions of a body merely *softened* by a solvent, which is afterwards withdrawn, as in the familiar instance of Indian Rubber, softened by naphtha for the manufacture of waterproof cloths; where the former, after being moulded or united in any way required, is left in its pristine condition by the evaporation of the naphtha from amongst its particles. But the cases of aggregation of solids, without such elevation of temperature, or the presence of solvents, are so rare, that but two or three have as yet been observed. Of these the most remarkable is that recorded by Pouillet, of the gradual, but complete, adhesion of surfaces of clean plate-glass, when left to repose on each other for a considerable time. It has also been stated, that clean plates of lead or of tin, if pressed together by a considerable force when cold, require a proportionably great force to separate them. The case presented to the Academy, therefore, is another added to these rare instances of molecular aggregation in solids, independent of solution or fusion: the author therefore thought it worth while to examine with a little care the properties both of the original brass, and of the mass thus curiously formed from it, or, as he thenceforth called them, of *the normal* and *the anomalous* alloy.

The normal alloy is of a bright gold colour, and sub-crystalline in structure, and of great toughness; its cohesive force is equal to 21.8 tons per square inch, which is above the average strength of any of the alloys of copper and zinc, or copper and tin, as found by my experiments on the cohesive power of these alloys, published in the Proceedings of the Academy, and elsewhere. The cohesive force of the anomalous alloy is only 1.43 tons per square inch, or only about one-fifteenth that of the former.

The specific gravity of the normal alloy is = 8.600; that of the anomalous only = 7.581.

On submitting both alloys to analysis, their constitution proved identical; it is as follows:

Copper	83.523
Tin	8.833
Zinc	7.510
Lead	0.024
Loss	0.110
	<hr/>
	100.000

Uniting the small amount of lead with the tin, and dividing by the atomic weights, the nearest approach to atomic constitution is,

Copper	=	26.3 atoms.
Zinc	=	2.3
Tin	=	1.5

These alloys have therefore not a strictly definite constitution, but one more nearly so than is usually found in commerce.

Both alloys are equally good conductors of electricity. The author examined their relative powers of conducting heat by the method which Despretz has employed with so much accuracy, and found that of the normal to that of the anomalous alloy as 36 : 35, numbers which are so nearly equal as to render it likely the difference is only error of experiment. He also endeavoured to determine their relative specific heats, using the method of mixture, which was the only one which the small size of the metals permitted, and eliminating the errors incident to this mode by first plunging the alloy hot into cold water, and then cold into hot water. In this way, if

w and t = the weight and temperature of the water,
 m and t' = the weight and temperature of the metallic alloy,
 m . . . = the mean temperature of both,
 s . . . = the specific heat of the alloy,
 there are two values, one where the metal is the hotter,

$$s = \frac{w(m-t)}{M(t'-m)};$$

and another where the water is the hotter body,

$$s = \frac{w(t-m)}{M(m-t')};$$

the mean of which is the specific heat of the alloy pretty exactly. The result gave the specific heat of the normal alloy = .0879, water as unity, and that of the anomalous alloy = .0848; both of which are below the specific heat assigned by Dalton to brass.

The normal alloy is malleable, flexible, ductile, and laminable. In the anomalous alloy there is an absolute negation of all these properties.

The normal alloy readily amalgamates with mercury, at common temperatures; the anomalous alloy will not amalgamate with mercury even at 400° Fahr.

When the anomalous alloy is heated to incipient redness in a glass tube, a minute trace of water, and of a burned organic substance, probably adherent oil, are discoverable; it suffers no change, however, but a slight increase of density. The normal alloy suffers no change when so treated. The normal alloy, treated on charcoal with the blow-pipe, fuses at once into a bead. On treating the anomalous alloy so, the fragment swells rapidly to more than twice its original bulk, on becoming bright red hot; it then glows, or becomes spontaneously incandescent, in the way that hydrated oxide of chrome and some others do, and instantly contracts to less than its original bulk, and becomes a fluid bead, which, on cooling, differs in no respect from the original alloy.

The anomalous alloy, when pulverized in an agate mortar, forms a *black powder*, devoid of all appearance of a metal; its filings also are quite *black*; while those of the normal alloy, produced by the same file, possess the usual metallic lustre. These facts, in connexion with the black

colour and fine earthy appearance of the fracture, bring to mind the case recorded by Sir David Brewster, of a piece of smoky quartz, the fracture of which was absolutely black, and yet was quite transparent to transmitted light, and whose blackness, he found, arose from the surfaces of fracture, consisting of a fine down of short and slender filaments of transparent and colourless quartz, the diameter of which was so small (not exceeding the one-third of the millionth part of an inch), that they were incapable of reflecting a single ray of the strongest light. In describing this, Sir David Brewster predicted, that "fractures of quartz and other minerals would yet be found which should exhibit a fine down of different colours depending on their size."

It seems, therefore, extremely probable, that the cause of the near approach to blackness in the fracture and filings of this alloy, arises from the excessive minuteness of its particles, and thus fulfils the foregoing prediction; the brownish tinge being produced by the reflexion of a little red light.*

The polish and power of reflecting light of the anomalous alloy are not quite so great as those of the normal, but are still remarkable; and, as it seemed a matter of some interest to determine whether both reflected the same quantity or intensity of light at equal angles, the author endeavoured to ascertain this point as respects heat, by means of Melloni's pile for the galvanometrical determination of temperature, assuming, as suggested to him by Professor Mac Cullagh, that what would be true of heat in this respect, would also be so of light; but from the small size of the reflecting surfaces he had at his command, he found it impossible to arrive at

* Since this paper was read, Professor Lloyd suggested to the author, the analogy between the appearance of the powder and filings of the anomalous alloy and Platina Mohr, and those powders obtained by reduction of other metals by hydrogen. None of these, however, are coherent, which constitutes the peculiarity in the present case.

any trustworthy result. He is, however, inclined to believe, that both metals reflect most at a perpendicular incidence.

From the foregoing detail of the properties, in several respects so different, of this substance in its normal and anomalous states, the author thinks he is warranted in pronouncing it the first observed instance of an approach to dimorphism in a metallic alloy; and one, the mode of production and characteristics of which present several points of interest.

The conditions under which the alloy was aggregated, involved extremely minute division of the metal, great pressure in forcing the divided particles into contact, and nearly the exclusion of air. Considerable electrical disturbance may have also co-operated; such, together with induced magnetism, being the constant accompaniments of motion in heavy machinery. By re-establishing these conditions, under suitable arrangements, the author hopes to repeat the results thus accidentally first obtained, and so produce possibly dimorphous states of other metals or their *definite* combinations.

There is but one body which occurred to the author, presenting an analogy to this anomalous alloy, namely, indigo; whose fracture, it is well known, is fine earthy, and of the usual blue colour, but becomes coppery, or assumes the metallic lustre on being rubbed or burnished.

DONATIONS.

Über den Galvanismus gegen örtliche Krankheiten, von Dr. Gustav Crusell.

Recueil des Acts de la Seance Publique de l'Académie Imperiale des Sciences de St. Petersburg, tenue le 29 Decembre, 1840.

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